Childhood Injuries in North Carolina: A Statewide Analysis of Hospitalizations and Deaths

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Abstract: We report the nature and causes of childhood injuries leading to hospitalization or death in North Carolina. Based on an 89 per cent sample of 1980 hospital discharges of children between 0 and 19 years of age, the overall annual rate of trauma-related hospitalizations was 80 per 10,000. The rate varied from 119 per 10,000 for the 15–19 year age group to 56 per 10,000 for children between ages 5 and 9. Hospitalization rates are lower than those reported elsewhere, although death rates, based on a seven-year period, are higher in the data reported here. Potential reasons for these differences are suggested. (*Am J Public Health* 1985; 75:1429–1432.)

Introduction

The role of injury as the leading cause of childhood mortality has been well documented.[1,2] There have been relatively few attempts, however, to examine the contribution of injuries to childhood morbidity or to compare the morbidity and mortality experiences of children by age group.

Using data from the Health Interview Survey, Starfield estimated that, during the course of a year, one in three children experiences an injury severe enough to limit the child's activity.[3] Gallagher, *et al*, described major types of fatal and nonfatal trauma and causes of those injuries in a sample of 23 Massachusetts hospitals.[4,5] Fife, *et al*, reported age-specific causes of injuries treated in a sample of 41 emergency rooms in northeastern Ohio.[6] These two studies found that approximately one in five children experiences an injury severe enough to require emergency room care in a year's period and that for every 17 to 28 children treated in an emergency room, one requires inpatient care. In the Massachusetts sample, injuries were responsible for 15 per cent of all pediatric admissions and 17 per cent of the total days of hospital care for children to the age of 20.

We examined the discharge diagnoses of hopsitalized children between 0 and 19 years of age in order to: document what types of hospitalizable trauma were experienced by North Carolina youth; examine the causes of those injuries; and compare age-specific causes of fatal and nonfatal cases.

Methods

Discharge data for 1980, reflecting approximately 89 per cent of all pediatric hospitalizations in the state were analyzed. (The 11 per cent of missing data tend to be from small, rural hospitals. In addition, there is an overrepresentation of Medicaid patients in the data set since reporting for this population is more complete.) All patients under age 20 who were hospitalized with a principal diagnosis in any of the specific ICD-9-CM categories listed in the Appendix were included. Types of injuries (N codes) were used to categorize the cases (including homicide and suicide attempts) within five age groups. Causes of injuries (E codes) were examined within four age groups. Mortality data derived from 1977–83 death certificates were analyzed according to the same E code categories as the hospitalizations. Seven years of deaths around 1980 were used so that more stable rates could be computed. Adjustments were made for minor differences between ICDA-8 and ICD-9-CM coding.

Rates are based on the 1980 census figures of 1,900,314 North Carolinians between ages 0 and 19. The hospital discharge and death data represent North Carolina residents. The discharge data were adjusted for missing data. Because rates with small numerators will have large random errors even in the case of a complete count where no sampling error is involved, we have flagged the rates in Tables 1 and 2 where the standard errors are large and where caution in interpretation should be exercised.

Results

Of approximately 137,700 hospital discharges during 1980 of persons in the 0–19 age range, 15,278 (11 per cent) listed an injury as the principal diagnosis (N code). Less than 1 per cent of these discharges were deaths. Sixty-seven per cent of the records with a principal diagnosis in the categories of interest also had a cause (E code) listed. Neither age nor principal diagnosis distribution differed meaningfully between those two-thirds of the discharges with E codes present and the remainder with no E codes recorded.

As indicated in Table 1, the annual rate of trauma-related hospitalizations for all the indicated conditions was 80.4 per 10,000 population. The rates are greatest for the 15–19 age group (119.4) who accounted for 44 per cent of the total injury-related hospitalizations while comprising only 30 per cent of the population between ages 0 and 19.

The nature of injuries requiring hospitalization varied by age. Infants were most likely to be hospitalized for head injuries and burns, followed by musculoskeletal injuries (i.e., fractures other than to the skull, sprains, strains and dislocations) and by poisoning. Toddlers' (ages 1–4) greatest vulnerability was to poisoning followed by head trauma and musculoskeletal injuries. Among those between ages 5 and 19, musculoskeletal injuries and head trauma were the major types. The risk of poisoning increased throughout the school age and adolescent years. Except for burns, poisonings, and foreign body-related injuries, 15–19 year olds were at greater risk of hospitalization than all other age groups for every specified injury type.

Causes of injuries also differed by age group (Table 2). For the youngest children, poisonings and falls were the most likely causes of hospitalization, followed by fires, flames and hot substances. In the younger school age group and young adolescents (age 5–14), falls were again the number of one cause of hospitalization, followed by injuries associated with machines or sharp objects or being struck

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TABLE 1—Injury Hospitalizations for Children in North Carolina, 1980, with Rates (per 10,000 population) by Discharge Diagnosis and Age†

Type of Injury (N Code)	Age Groups: 0–4 ≤ 1 #	0–4 1–4 #	0–4 #	0–4 Rate	5–9 #	5–9 Rate	10–14 #	10–14 Rate	15–19 #	15–19 Rate	Total #	Total Rate
Head injuries	204	441	645	16.0	675	15.1	724	15.0	1392	24.6	3436	18.1
Musculoskeletal injuries	66	379	445	11.0	816	18.2	1222	25.3	2642	46.7	5125	27.0
Internal injuries	2	25	27	0.7*	62	1.4	88	1.8	252	4.4	429	2.3
Wounds	27	301	328	8.1	421	9.4	439	9.1	1043	18.4	2231	11.7
Contusions/crushings	24	106	130	3.2	165	3.7	192	4.0	358	6.3	845	4.4
Foreign bodies	45	139	184	4.6	83	1.9	49	1.0*	25	0.4*	341	1.8
Burns	97	236	333	8.2	98	2.2	73	1.5	156	2.8	660	3.5
Nerves/Spinal cord	1	6	7	0.2*	13	0.3*	31	0.6*	61	1.1	112	0.6
Poisoning	63	598	661	16.4	109	2.4	215	4.5	666	11.8	1651	8.7
Other/unspecified	37	99	136	3.4	67	1.5	76	1.6	169	3.0	448	2.4
TOTAL	566	2330	2896	71.7	2509	56.0	3109	64.5	6764	119.4	15278	80.4
Per cent of all injuries in 0–19 age group	3.7%	15.3%	19.0%		16.4%		20.3%		44.3%		100.0%	

†Rates were computed using age-specific 1980 Census population; figures have been adjusted for 89% reporting.
*Small numerator in the rate results in 95% confidence interval that is greater than plus or minus 25% of the rate (i.e., 1.96 standard errors is greater than 25% of the rate).

TABLE 2—Injury-related Hospitalizations (1980) and Deaths (1977–83) per 10,000 Population Per Year among Children in North Carolina, by Cause and Age†

External Cause (E Code)	Age Groups: 0–4 Hospitalization Rate	0–4 Death Rate	5–9 Hospitalization Rate	5–9 Death Rate	10–14 Hospitalization Rate	10–14 Death Rate	15–19 Hospitalization Rate	15–19 Death Rate	Total Hospitalization Rate	Total Death Rate
Motor Vehicle	6.3	0.53	6.9	0.24	9.9	0.52	39.2	3.97	17.2	1.48
Pedestrian	1.7	0.38	3.1	0.57	1.6	0.25	1.3	0.30	1.9	0.37
Pedal Cycle	1.1*	0.01*	6.6	0.13*	4.8	0.20	1.1*	0.05*	3.3	0.10
Other Transport	1.1*	0.20*	1.9	0.10*	2.5	0.08*	2.2	0.15	2.0	0.13
Poisoning	20.3	0.08*	1.6	0.01*	1.1*	0.01*	2.1	0.12*	5.6	0.06
Falls	19.2	0.07*	16.2	0.01*	14.8	0.02*	15.1	0.07*	16.2	0.05
Drowning	0.5*	0.33	0.6*	0.24	0.2*	0.38	0.5*	0.61	0.5	0.40
Suffocation/Foreign bodies	4.6	0.38	1.1*	0.03*	1.4*	0.06*	0.5*	0.05*	1.7	0.12
Fires and Flames/Hot Substances	8.0	0.75	2.0	0.18*	1.2*	0.08*	2.3	0.11*	3.2	0.25
Cut/Struck/Machinery	6.7	0.08*	11.0	0.04*	12.1	0.04*	19.0	0.09*	12.8	0.06
Firearms/Explosions	0.5*	0.05*	0.7*	0.04*	1.3*	0.12*	3.2	0.16	1.5	0.10
Suicide/Homicide	2.9	0.44	0.9*	0.08*	4.6	0.19	21.6	1.57	8.4	0.63
Other and Unspecified	4.9	0.09*	3.7	0.02*	4.7	0.04*	8.8	0.15	5.7	0.08
TOTAL	77.8	3.38	56.2	1.68	60.3	2.00	117.1	7.40	80.0	3.83

†Hospitalization rates are for 1980 and death rates are for the period 1977–1983; rates were computed using age-specific census population; hospitalization rates have been adjusted for 89% discharge reporting and 67% E code reporting, which assumes equal distributions of non-reporting by ages and E codes.
*Small numerator in the rate results in 95% confidence interval that is greater than plus or minus 25% of the rate (i.e., 1.96 standard errors is greater than 25% of the rate).

and by motor vehicles. For older adolescents, ages 15–19, motor vehicles were the principal cause of trauma, followed by suicide and homicide attempts.

Within age groups, the relative size of mortality and morbidity rates differ by cause. (Comparison of the age-cause-specific rates in Table 2 should be made carefully since many of these have large standard errors due to small numerators.) For example, for drowning the rates of hospitalization and death are similar in some age groups, while for other causes such as motor vehicle events, the rates of hospitalization are much higher than the death rates. Moreover, the ranking of causes within age group may differ substantially for hospitalizations and deaths. For example, in the 15–19 age group, drowning is the third leading cause of death (Table 2) but ranks nearly last as a cause of hospitalization.

Discussion

Because of differences in age stratification and categorizations of several injury types, precise comparisons to other studies are impossible. The patterns in the data presented here are similar to previous reports with the exceptions noted below.[4–6]

The overall injury mortality rate reported in the Massachusetts studies (2.55 deaths per 10,000 child years)[4] is substantially lower than the rate of 3.83 per 10,000 population computed for North Carolina. The Gallagher, *et al*, report[4] excludes homicide and suicide attempts while we have included them. These causes account for 11 per cent of North Carolina injury hospitalizations between ages 0 and 19 and 15 per cent of deaths in that age group. The differences observed between North Carolina and Massachusetts still hold if these causes are excluded from the North Carolina data (i.e., the North Carolina death rate is 3.20 vs 2.55 for Massachusetts). Furthermore, the ratio of hospitalizations to deaths is considerably different across studies. In the 1982 and 1984 Massachusetts reports,[4,5] a ratio of 44:1 was reported. In contrast, the ratio of hospitalizations to deaths from our North Carolina data is 21:1. This difference in ratios is due predominantly to the higher death rate in North Carolina, although the rate of hospitalization in North Carolina is 20 per cent lower than that in Massachusetts.

One might speculate that the severity of traumatic events varies between these two locales. It is also possible that, given the same traumatic event, access to medical services may contribute to variation in both death rates and hospitalization to death ratios. Differences in both rurality and poverty are potential explanations of the observed differences. In North Carolina, 16.4 per cent of the population lives in poverty while the figure for Massachusttes is 9.9 per cent.[5,7] A recent analysis of data from the state of Maine revealed that children living in poverty experience a 2.6 times greater injury mortality risk than those from higher income groups.[8] This difference may be a function of increased exposure to hazardous environments[9] or to limitations in access to medical care.

The contribution of a rural environment could likewise operate at the level either of exposure or access to care. It has been demonstrated, for example, that motor vehicle trauma is more severe in rural crashes, largely because of the higher speeds involved.[2] It may also be that, in rural areas, the distance to acute medical services for any type of care, and especially to tertiary care centers for treatment of more severe forms of trauma, contributes to the observed differences. Furthermore, the interplay of poverty and access to services is of concern. Recent case reports suggest that a patient's ability to pay may influence access to acute care and subsequent decisions to transfer patients to public hospitals, potentially increasing risks associated with both transport and the delay of care.[10,11]

Finally, it is possible that the observed differences are attributable in part to inconsistencies in the reporting of deaths and/or hospitalizations within either state or between the two states. The overrepresentation of Medicaid patients in the North Carolina sample might inflate the hospitalization estimates, although the effect is probably small since Medicaid patients are a small proportion of the total. With the missing hospital discharges (11 per cent) concentrated in rural hospitals, the North Carolina rate would be somewhat understated if the rate of hospitalization due to injuries is greater in rural areas.

In summary, this study serves to provide further documentation of the importance of childhood injuries as a source of morbidity and mortality; points to important differences in injury rates and causes among age groups; and emphasizes the need to attend to both intentional injuries (due to homicide and suicide) as well as to unintentional events. Finally, it raises new questions about the factors associated with exposure to injuries and access to trauma services among different population groups.

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APPENDIX
NATURE OF INJURY AND EXTERNAL CAUSE CATEGORIES AND CORRESPONDING ICD-9-CM CODES

Nature of Injury (N-Code) Categories	ICD-9-CM rubrics	ICD-9-CM codes
Head injuries	Fracture of skull	800–804
	Intracranial injury	850–854
Musculoskeletal injuries	Other fractures	805–829
	Dislocation	830–839
	Sprains and strains	840–848
Internal injuries	Internal injuries	860–869
Wounds	Open wound	870–897
	Injury to blood vessels	900–904
	Superficial injury	910–919
Contusions/crushings	Contusion	920–924
	Crushing injury	925–929
Foreign bodies	Foreign body	930–939
Burns	Burns	940–949
Nerves and spinal cord	Injury to nerves and spinal cord	950–957
Poisoning	Poisoning by drugs	960–979
	Toxic effects of non-medicals	980–989
Other/unspecified	Complications and unspecified injuries	958–959
	Other/unspecified effects (includes drowning and electrocution)	990–995

External Cause (E-Code) Categories	ICD-9-CM rubrics	ICD-9-CM codes
Motor vehicles	Motor vehicle—occupant	E810–E819 (.0,.1,.8,.9)
	Motorcycle	E810–E819 (.2,.3)
Pedestrian	Motor vehicle—pedestrian	E810–E819 (.7)
Pedal cycle	Pedal cycle—motor vehicle	E810–E819 (.6)
	Pedal cycle—non-motor vehicle	E826
Other transport	Railway	E800–E807
	Other motor vehicle traffic	E810–E819 (.4,.5)
	Other road vehicle and non-traffic	E820–E825, E827–E829
	Air and water transport	E830–E845
Poisons	Poisoning by drugs	E850–E858
	Poisoning by other substances	E860–E869
Falls	Accidental falls	E880–E888
Fire and flames/hot substances	Fire and flames	E890–E899
	Hot or corrosive substance or object	E924
Drowning	Drowning	E910
Suffocation/foreign bodies	Inhalation, ingestion, suffocation	E911–E913
	Foreign body	E914–E915
Cut/struck/machinery	Struck by or caught in object	E916–E918
	Machinery	E919
	Cutting and piercing objects	E920
Firearms/explosions	Explosions of vessels	E921
	Firearms	E922
	Explosive material	E923
Suicide/homicide	Suicide	E950–E959
	Homicide	E960–E969
	Legal intervention	E970–E978
	Undetermined	E980–E989
	War	E990–E999
Other and unspecified	Natural and environmental factors	E900–E909
	Radiation	E926
	Other and unspecified	E928
	Electric current	E925